An Evaluation of Five Systems for Handling Frozen Food From Processor to Wholesale Warehouse

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PREFACE

This study is part of a continuing research program of the Agricultural Marketing Research Institute, Agricultural Research Service, designed to find more efficient and less costly systems for handling agricultural products from producer to consumer.

Appreciation is expressed to all frozen food processors and wholesalers who participated in this research. Appreciation is also expressed to Charles L. Goulson, industrial engineer, Market Operations Research Laboratory, Agricultural Marketing Research Institute, who assisted in collecting data at the wholesale warehouses. The Paul F. Shaffer Company of Miami, Fla., provided data on loading frozen food at the processing plants.

This study was conducted under the general direction of John C. Bouma, Chief, Market Operations Research Laboratory, Agricultural Marketing Research Institute.

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AN EVALUATION OF FIVE SYSTEMS FOR HANDLING FROZEN FOOD FROM PROCESSOR TO WHOLESALE WAREHOUSE

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SUMMARY

Costs of five systems for handling frozen food were developed. A system included (1) product assembly, checking, and loading transport vehicles at the processing plant, (2) transporting, and (3) unloading, checking, and storage at the wholesale warehouse. The five systems were handstacked, palletized, clamp-loaded, clamp-loaded and clamp-unloaded, and slipsheeted.

Models were constructed to reflect costs for transporting frozen food products between southern Florida and Washington, D.C., a distance of approximately 1,200 miles.

The least costly of the five systems studied was the clamp-loaded and clamp-unloaded system, totaling $893.35 per trailer load (40-foot length, 1,600 cases). Of this total, $17.83 was for controllable costs (labor, equipment, and material) and $875.52 for transportation. This was followed by the clamp-loaded system at $904.93 (controllable cost $29.41, transportation $875.52), the slipsheeted system at $905.46 (controllable cost $29.94, transportation $875.52), the handstacked system at $911.61 (controllable cost $36.09, transportation $875.52), and the palletized system at $989.54 per trailer load (controllable cost $21.97, transportation $908.35, and pallet return $59.22). Thus, controllable costs ranged from $17.83 to $36.09 per trailer load, with the handstacked system costing more than twice as much as the lowest cost innovative system (clamp-loaded and clamp-unloaded).

In the palletized system the weight of pallets contributed an additional $32.83 to the cost of shipping products on pallets, and returning pallets to the processor cost $59.22. These added costs more than offset the advantages of lower labor costs in both loading and unloading with the palletized system.

The added material cost with the slipsheeted system ($7.20 for 18 slipsheets) offset the advantage of having a total labor cost below that of the clamp-loaded system.

A clamp-loaded and clamp-unloaded system would offer the lowest total cost. As of now very few receivers employ forklift trucks with clamp attachment

for unloading, but this system offers advantages over the other systems. No shipping platform is employed; it adds costs to the palletized and slipsheeted systems. Labor cost is lower with a clamp-loaded and clamp-unloaded system than with a handstacked system. A clamp-loaded and clamp-unloaded system for handling frozen food at the processing plant and at the wholesale warehouse instead of the next least cost system (clamp-loaded) would result in a savings of approximately $11 per trailer load.

The following conclusions can also be drawn from the research:

- The unitized systems (palletized, clamp-loaded, and slipsheeted) can reduce labor costs for loading and unloading.
- Communication between processor and receiver should be improved.
- A pallet-exchange program is needed.
- A standard-sized pallet should be used.
- Ways to reduce transportation charges should be studied.

INTRODUCTION

The frozen food industry is a large complex industry producing and marketing hundreds of diversified food items. The accelerated growth of this industry has been due principally to the technological advancements since the 1950's. These include (1) development of equipment capable of quick freezing large quantities of products to protect and preserve their quality, (2) improved transportation and warehouse refrigeration facilities to maintain products at low temperatures, (3) improvement of retailer's storage and display equipment, and (4) expanded variety of products with consumer appeal. All these improvements have made frozen food one of the fastest growing segments of the entire food industry in the United States.

By the early 1940's the frozen food industry was well established and production reached 648 million pounds but with relatively few types of major food items. By 1955, production totaled 4.1 billion pounds; in 1960, 6.4 billion pounds; and in 1970, 11.7 billion pounds. By 1972, sales reached $5.8 billion and by 1976 are expected to exceed $7.2 billion. During 1971-76 the number of frozen food items carried by a typical retailer is expected to increase 50 percent, from 400 to approximately 600 items. By the early 1980's, frozen food retail sales are expected to reach about $10.2 billion, a 76-percent increase over 1972, and will represent 9.7 percent of all retail food purchases.[1/]

Very little research has been conducted to evaluate the ever-enlarging and complex marketing system for frozen food. Today there are many ways of handling and marketing frozen food through the distribution network, and some may be more efficient and less costly than others.

The purpose of this study was to examine and analyze five systems for handling frozen food products between processing plants and wholesale warehouses. These systems include products (1) handstacked in trailers at the

1/ National Frozen Food Association, Inc. The retail grocery market for frozen food. V. 2. Hershey, Pa. 1974.

processing plant and unloaded by hand onto pallets at the wholesale warehouse; (2) palletized, moved directly from freezer storage by forklift truck, placed in the trailer at the processing plant, and unloaded at the warehouse; (3) clamp-loaded, removed from freezer storage pallets by forklift truck with clamp attachment, loaded in the trailer at the processing plant, and unloaded by hand onto pallets at the warehouse; (4) clamp-loaded, removed from freezer storage pallets by forklift truck with clamp attachment and clamp-unloaded onto pallets at the warehouse; and (5) slipsheeted, removed from freezer storage pallets by forklift truck with clamp attachment, placed on slipsheets, loaded into the trailer at the processing plant, and unloaded onto pallets at the warehouse.

METHODOLOGY

For this report, a system consists of loading, transporting, and unloading.

Loading began when the commodity was removed from freezer storage and moved to the transport vehicle. Loading was completed when the last case was securely in place in the transport vehicle, the dock plate was removed, and the trailer doors were closed.

Transporting of the commodities began when the transport vehicle left the loading area at origin and ended with arrival at destination. Transportation was the same for the five systems. A refrigerated highway trailer van, 40 feet long, was the transport vehicle.

Unloading began when trailer doors were opened and the dock plate was positioned; it was completed when the last case was in place in the warehouse storage area.

The systems for handling frozen food from storage at the processing plant to storage at the wholesaler's warehouse were analyzed to measure the costs of labor, equipment, and material, based on 1,600 cases per trailer load. The labor man-hour requirements were converted to costs using the prevailing wage rates for these job categories as reported by the processors and wholesalers. A 20-percent fatigue and personal allowance was added to freezer labor requirements because employees needed additional time to warm up after working in the freezers, and 15 percent was added to all other labor requirements to provide a standard time for performing various operations. The equipment-hour requirements were converted to costs using hourly ownership and operating costs developed in table 9 (appendix).

Most of the information was obtained from detailed time studies at each of the facilities studied and was supplemented by personal interviews with managers, truckers, employees, equipment manufacturers, government officials, and others involved with the handling of frozen food.

Before the data were collected, researchers observed operations at processing plants, wholesale warehouses, and public refrigerated warehouses. Product types, case weights and sizes, cases per trailer load, handling methods, and transport vehicle variations were noted. For example, case weight was

found to range from 6 to 50 pounds, cases per trailer load were from 200 to 3,100, and transport vehicles were from 20-foot straight trucks to 40-foot trailers.

Handling methods were observed at four frozen food processing plants, two wholesale warehouses, and two public refrigerated warehouses. At the processing plants, cases of product were generally removed from storage on pallets and transported to trailer loading areas, where various loading methods were used. Costs were not considered for warehouse operations, equipment, or materials that were not directly related to loading and unloading.

The wholesale warehouses received over 50 trailer loads of frozen food per week. These handstacked or unitized shipments came directly from the processing plant or public refrigerated warehouse. Checking time was not considered a part of unloading at the wholesale warehouse as it was at the processing plant. Checkers or dock supervisors at the warehouse did not participate in the actual unloading.

To determine the costs of the five systems, the following assumptions were made to reduce the number of variables:

(1) Product: Frozen citrus was chosen as the representative product. However, almost any frozen food product could have been selected.

(2) Product case: Medium-sized retail-packaged case weighing 24 pounds.

(3) Trailer load: 1,600 cases.

(4) Shipping and receiving points: The representative trip between processor and wholesaler was Miami, Fla., to Washington, D.C., a distance of about 1,200 miles.

(5) Trailer: Refrigerated highway trailer with inside dimensions of 37 feet 3 inches by 7 feet 4 inches by 7 feet 4 inches.

(6) Transportation rate: $2.28 per hundredweight by common carrier to transport frozen citrus from Miami to Washington and $4.12 per hundredweight by common carrier to transport pallets from Washington to Miami. These rates were obtained from the Federal Supply Service of the General Services Administration.

HANDSTACKED SYSTEM

Loading.--In the handstacking system the forklift truck operator transported loaded pallets from the freezer to the loading dock. Three loaders working in the trailer transferred the frozen food cases from the loaded pallets to the trailer floor (fig. 1). A checker was used in all five systems to (1) direct the loader in the freezer, (2) count cases, (3) tell the crew when to remove a partly full pallet, and (4) watch for damaged cases.

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Figure 1.--Handstacking frozen food cases in a highway trailer at processing plant.

The cost of labor and equipment was $14.51, as shown in table 1.

Transportation.--Based on $2.28 per hundredweight and a load of 384 hundredweight, this cost amounted to $875.52 per trailer.

Unloading.--After the rear doors of the trailer were opened and the dock plate was positioned, warehouse personnel or the truck driver secured a stack of pallets by hand and positioned them on the loading dock near the rear of the trailer. As a pallet was needed, the driver either hand-carried it into the trailer or used a pallet jack. Occasionally assisted by a helper, he then handstacked frozen food cases on the pallet (fig. 2). The driver obtained the pallet pattern and number of layers to stack on the pallet from warehouse personnel. When the pallet was loaded, an empty pallet was placed on top of it and loaded. When this second pallet was loaded, both were removed from the trailer by an electric pallet jack and set down on the loading dock (fig. 3). From the loading dock a warehouse employee transported the double-stacked pallets into storage (fig. 4).

The labor and equipment time and costs to unload 1,600 handstacked cases from a refrigerated highway trailer are shown in table 2. The total cost to stack the cases on pallets, remove them from the trailer, and transport to storage was $21.58. Of this amount, labor cost to handstack cases on the pallets was $14.49 or 67 percent of the total cost at the wholesale warehouse.

The cost of the handstacked system to handload the trailer at the processing plant ($14.51), transport ($875.52), and unload by hand at the wholesale warehouse ($21.58) totaled $911.61.

Table 1.--Handstacked system: Labor and equipment time and costs to transport 1,600 palletized cases from freezer and handstack in trailer at processing plant 1/

Element	Labor		Equipment		Total cost
	Time	Cost	Time	Cost	
	Man-hours	Dollars	Hours	Dollars	Dollars
Transport cases from freezer to dock by forklift truck (round trip 300 ft).	0.76	2.05	0.76	0.75	2.80
Handstack cases in trailer from pallets moved by forklift truck.	4.04	10.90	.82	.81	11.71
Total.....	4.80	12.95	1.58	1.56	14.51

1/ Labor and equipment costs, respectively, at $2.70 and $0.99 per hour. Same forklift truck used to move pallets of frozen food from storage and later into trailer.

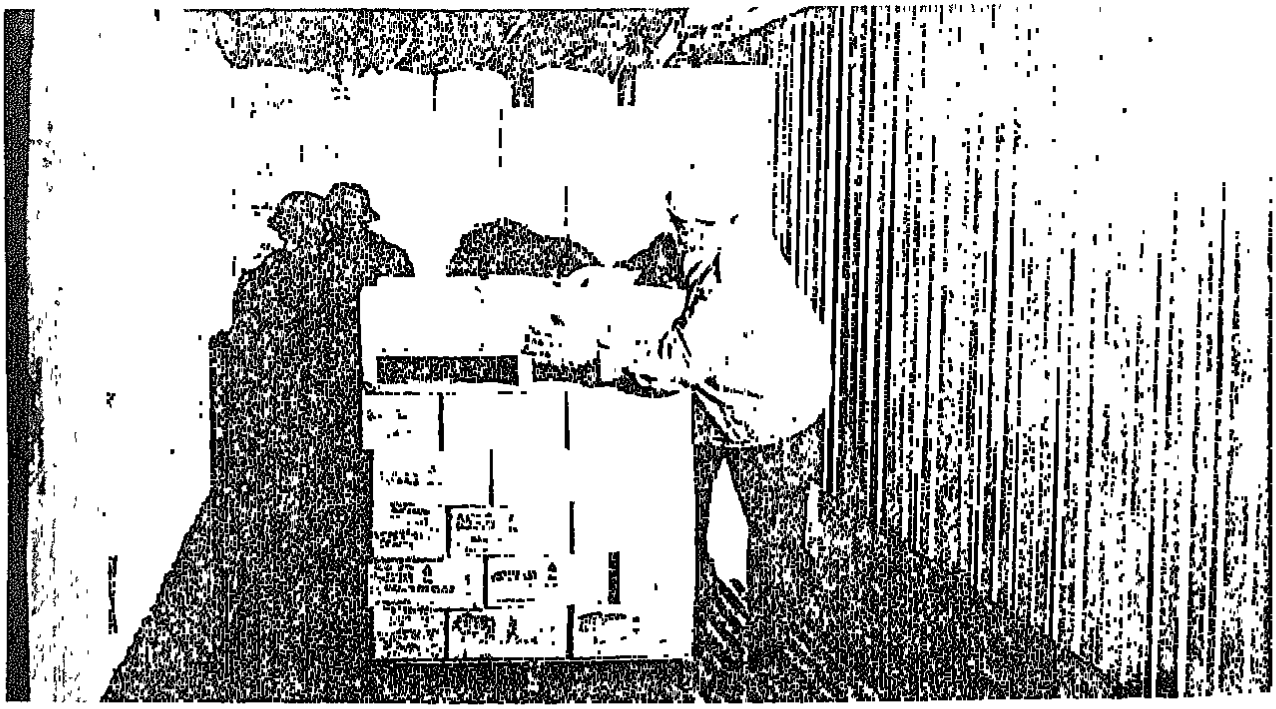

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Figure 2.--Handstacking frozen food cases on pallet in trailer for unloading at wholesale warehouse.

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Figure 3.--Two pallet loads being removed from trailer as a single unit by electric pallet jack at wholesale warehouse.

Table 2.--Handstacked system: Labor and equipment time and costs to unload 1,600 handstacked cases of frozen food and move to storage

Element	Labor		Equipment		Total cost
	Time	Cost 1/	Time	Cost 2/	
	Man-hours	Dollars	Hours	Dollars	Dollars
Position pallet.....	0.16	0.92	...	...	0.92
Handstack cases on pallets (approx. 44 cases per pallet for 36 pallets)	2.52	14.49	...	...	14.49
Remove 2 loaded pallets at a time from truck by pallet jack (18 round trips of 125 ft each).	.46	2.65	0.46	0.18	2.83
Move 2 loaded pallets at a time from dock to storage by fork-lift truck (18 round trips of 280 ft each).	.49	2.82	.49	.52	3.34
Total	3.63	20.88	.95	.70	21.58

1/ At $5.75 per hour.
2/ At $0.41 and $1.08 per hour for 1st and 2d cost data, respectively.

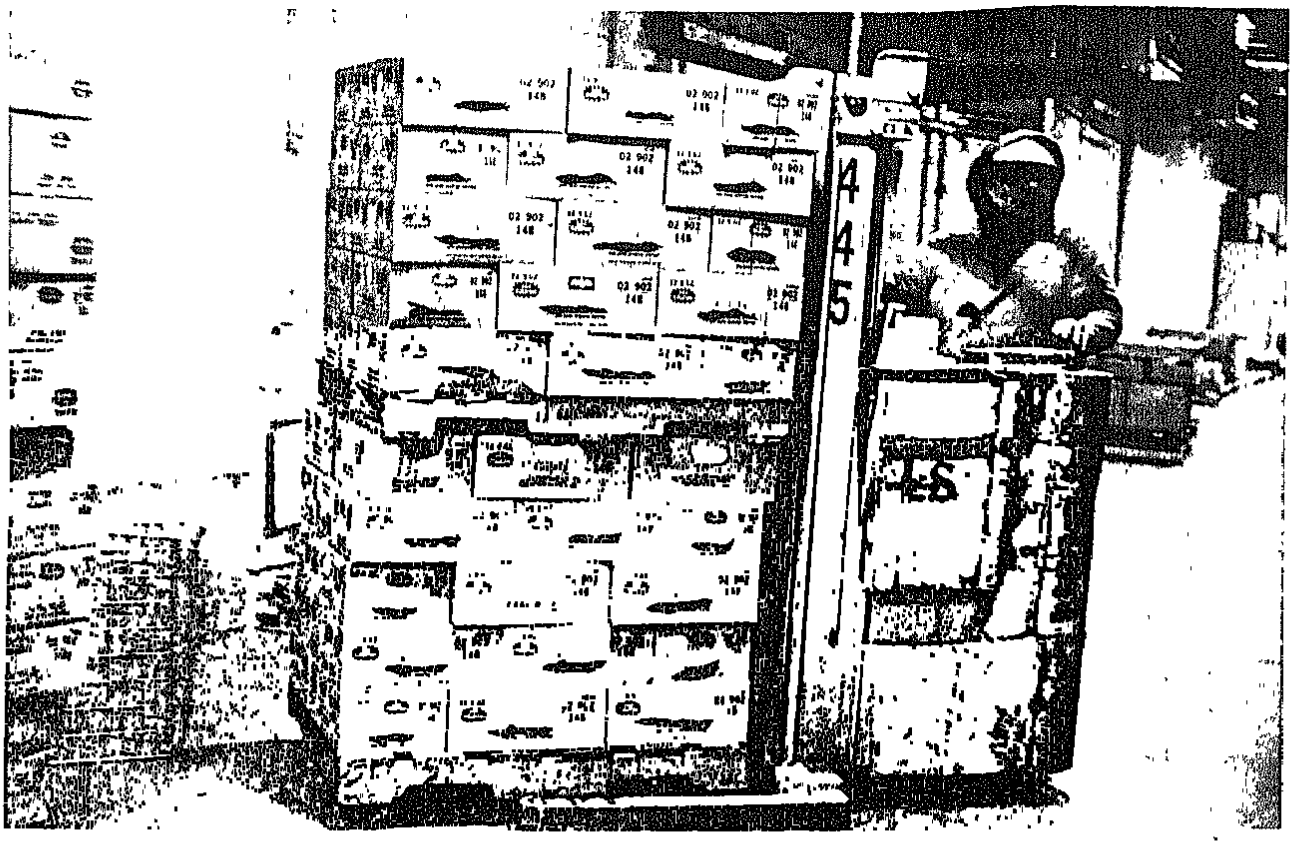

Figure 4.--Two pallet loads of frozen food being transported from loading dock by stand-up rider forklift truck to storage in warehouse.

PALLETIZED SYSTEM

Loading.--In the palletized system a forklift truck operator transported loaded pallets directly from freezer storage to the trailer at the processing plant (fig. 5). A helper was available for any reorganizing of cases on the pallets. The loading crew included one forklift truck operator, a loader or helper, and a checker.

In this system a hypothetical pallet arrangement between the processor and wholesaler is assumed. Pallet costs were assumed to include ownership ($10) and maintenance ($15) expense for 60 trips, totaling $25 per pallet. The per trip cost was $0.42 per pallet or $7.56 per trailer trip ($0.42 X 18 pallets).

The wholesale warehouse returned periodically full trailer loads of pallets to the processing plant. At $4.12 per hundredweight and a total of 20,000 pounds (250 pallets at 80 pounds each), transport charges were $824 or $3.29 per pallet and $59.22 for 18 pallets.

Labor and equipment time and costs to transport 1,600 cases of frozen food from freezer storage and load in the trailer are shown in table 3. Total cost amounted to $5.47.

-Palletized system: Labor and equipment time and costs to transport 1,600 palletized cases from freezer and load in trailer at processing plant 1/

Element	Labor		Equipment		Total cost
	Time	Cost	Time	Cost	
	Man-hours	Dollars	Hours	Dollars	Dollars
Transport cases from freezer to to dock by forklift truck (round trip 300 ft).	0.76	2.05	0.76	0.75	2.80
Move 18 loaded pallets into trailer by forklift truck.	.85	2.29	.39	.38	2.67
Total.....	1.61	4.34	1.15	1.13	5.47

1/ Labor and equipment costs, respectively, at $2.70 and $0.99 per hour. Same forklift truck used to move frozen food from storage and later into trailer.

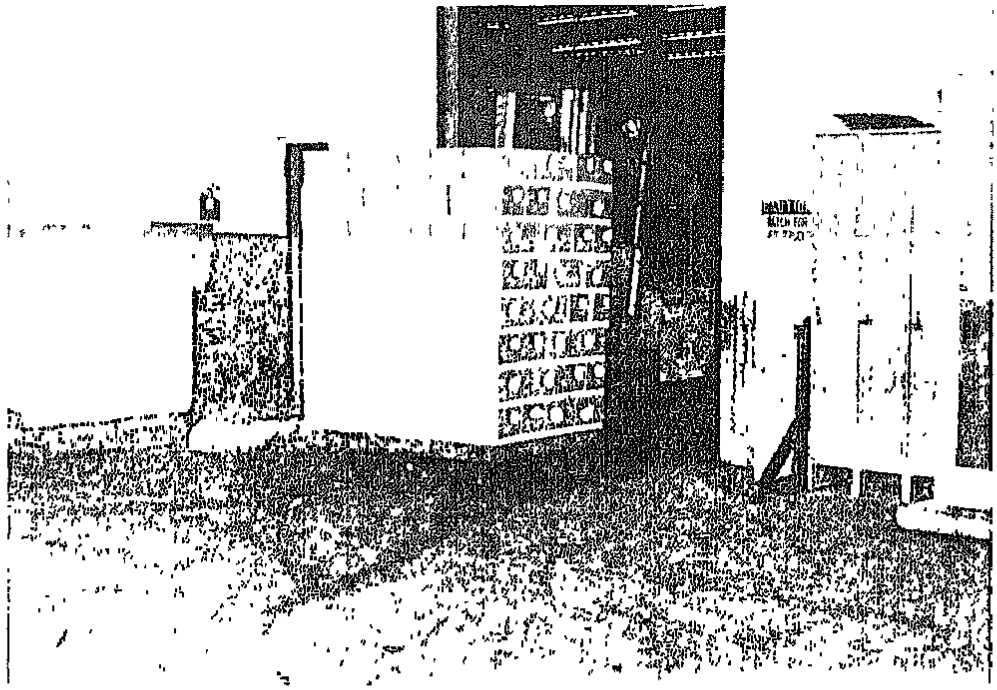

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Figure 5.--Loaded pallet being transported from freezer storage to loading dock at processing plant.

Transportation.--Based on $2.28 per hundredweight and a load of 384 hundredweight for product and 14.4 hundredweight for pallets (80 lb X 18 palleta = 1,440 lb), this cost amounted to $908.35 per trailer ($875.52 for the product; $32.83 for the palleta).

Unloading.--Pallet loads that had not shifted during transit were easily moved from the trailer to the dock by one man with an electric pallet jack. Occasionally pallet loads that had fallen together in transit were difficult to separate and caused some delay in unloading. Where cases fell off the pallet, they had to be repositioned before the pallet load was removed from the trailer. One full pallet at a time was unloaded from the trailer (fig. 6). If the pallet load was too high for the storage racks, a few layers of cases would be removed and placed on another pallet. From the dock a warehouse employee transported the loaded pallets into storage and positioned them in the correct location (fig. 7).

The labor time and costs to unload 1,600 frozen food cases on 18 pallets from a refrigerated highway trailer are shown in table 4. The total labor and equipment cost to remove the loaded pallets from the trailer and transport to storage was $8.94.

The cost of the palletized system to load at the processing plant ($5.47) plus the pallet cost ($7.56), transport ($908.35), unload at the wholesale warehouse ($8.94), and return 18 pallets ($59.22) totaled $989.54.

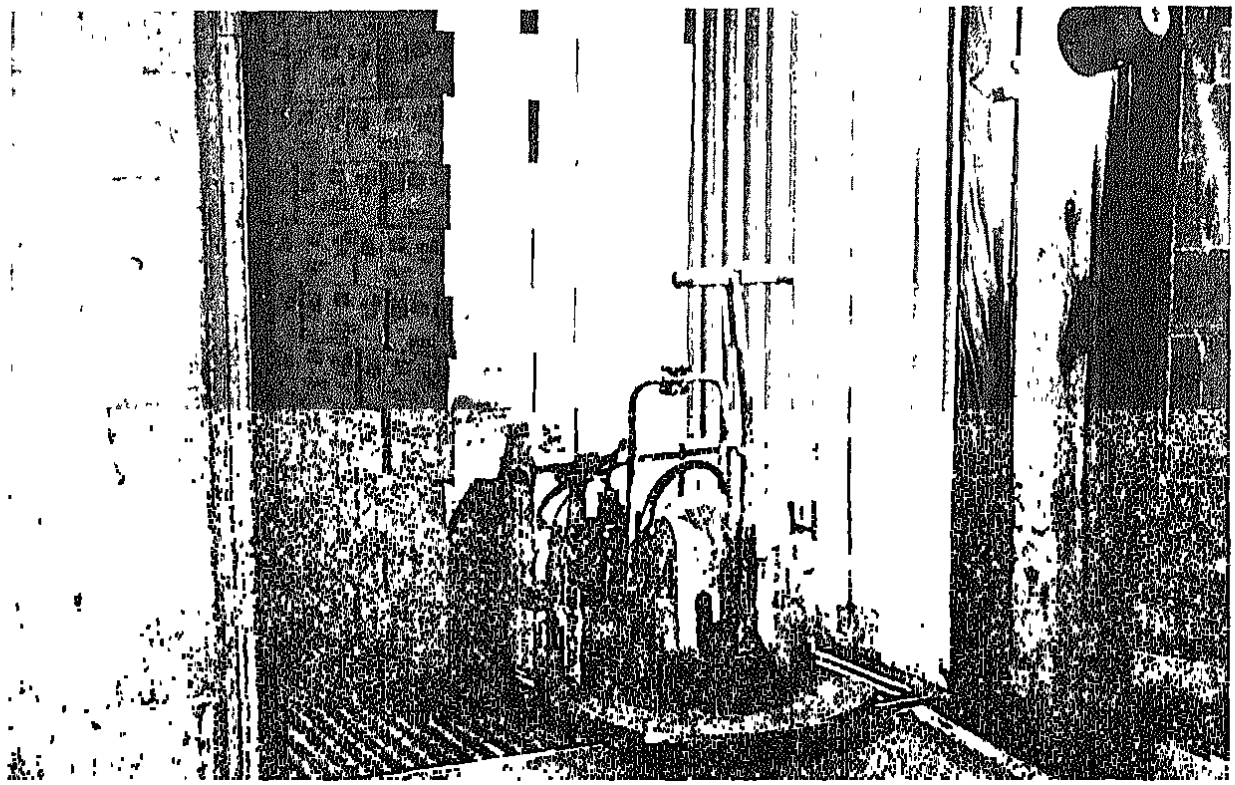

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Figure 6.--Pallet load of frozen food ready for removal from palletized trailer load at wholesale warehouse.

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Figure 7.--Pallet loads of frozen food being positioned in storage.

Table 4.--Palletized system: Labor and equipment time and costs to unload 1,600 palletized cases of frozen food and move to storage

Element	Labor		Equipment		Total cost
	Time	Cost 1/	Time	Cost 2/	
	Man-hours	Dollars	Hours	Dollars	Dollars
Remove 18 loaded pallets from truck by pallet jack (18 round trips of 125 ft each).	0.64	3.68	0.64	0.26	3.94
Adjust pallet load on dock.....	.29	1.66	...	...	1.66
Move 18 loaded pallets from dock to storage by forklift truck (18 round trips of 280 ft each).	.49	2.82	.49	.52	3.34
Total	1.42	8.16	1.13	.78	8.94

1/ At $5.75 per hour.
2/ At $0.41 and $1.08 per hour for 1st and 2d cost data, respectively.

Loading.--In the clamp-loaded system a forklift truck operator obtained pallet loads from the freezer and transported them to the loading dock near the trailer door. An operator using a forklift truck with a clamp attachment positioned the clamp around the unitized load (fig. 8), picked it up from the pallet, transported it into the trailer, and placed it on the floor (fig. 9). A checker assigned to each trailer verified the number of cases loaded. The crew included two forklift truck operators, one loader who straightened cases on the unitized loads, and one checker.

Labor and equipment time and costs to transport 1,600 cases from the freezer and load in the trailer are shown in table 5. Costs totaled $7.83.

Transportation.--Based on $2.28 per hundredweight and a load of 384 hundredweight, this cost amounted to $875.52 per trailer.

Unloading.--Shipments clamp loaded at origin were unloaded by hand at the wholesale warehouse in the same manner as incoming handstacked loads. The labor and equipment costs in table 2 ($21.58) for unloading handstacked cases apply to unloading here.

The clamp-loaded system cost $904.93 to clamp load ($7.83), transport ($875.52), and unload handstacked cases ($21.58).

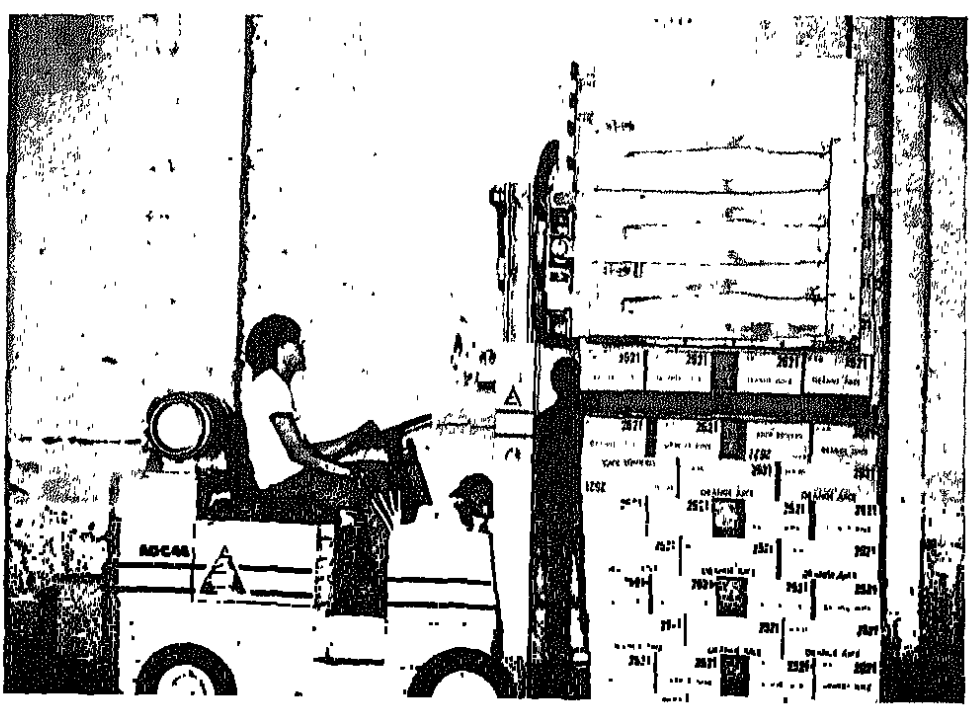

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Figure 8.--Positioning clamp to remove unitized load from pallet on dock.

Table 5.--Clamp-loaded system: Labor and equipment time and costs to transport 1,600 palletized cases from freezer and load in trailer at processing plant by forklift truck with clamp attachment

Element	Labor		Equipment		Total cost
	Time	Cost 1/	Time	Cost 2/	
	Man-hours	Dollars	Hours	Dollars	Dollars
Transport cases from freezer to dock by forklift truck (round trip 300 ft).	0.76	2.05	0.76	0.75	2.80
Load cases in trailer by forklift truck with clamp attachment.	1.49	4.02	.78	1.01	5.03
Total.....	2.25	6.07	1.54	1.76	7.83

1/ At $2.70 per hour.
2/ At $0.99 and $1.30 per hour for 1st and 2d cost data, respectively.

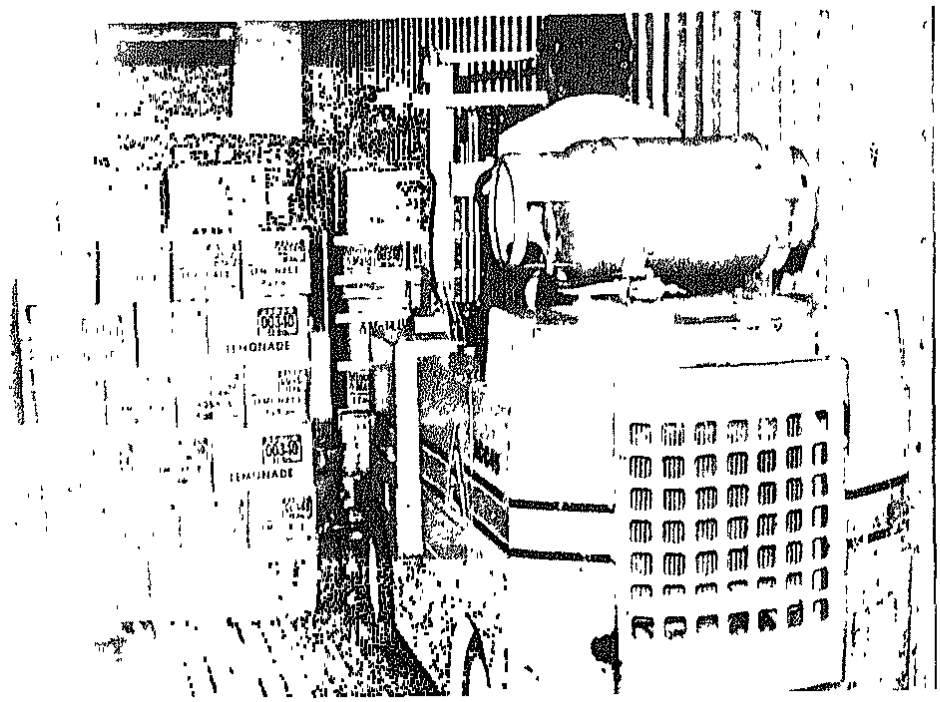

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Figure 9.--Placing unitized load directly on trailer floor using forklift truck with clamp attachment.

CLAMP-LOADED AND CLAMP-UNLOADED SYSTEM

The wholesale warehouses studied did not use forklift trucks with clamp attachment for unloading. If the unloading had been done with these trucks, labor and equipment costs would have been less than hand unloading. Since clamp-unloading and slipsheeted unloading times and costs would be similar, clamp-unloading costs would be approximately $9 for labor and $1 for equipment. An entire clamp-loaded and clamp-unloaded system would have been the least expensive of the systems studied. Clamp-loaded costs at the processing plant were $7.83 for labor and equipment (table 5), approximately $10 for unloading at the wholesale warehouse, and $875.52 for transportation, totaling $893.35 for this system.

Very few receivers use forklift trucks with clamp attachments for unloading, but this method would reduce labor and equipment costs for the receiver and thereby reduce the total cost for handling and transporting frozen food and make this the lowest cost system.

SLIPSHEETED SYSTEM

Loading.--In the slipsheeted system slipsheets were used. They are disposable shipping platforms made of corrugated fiberboard. Being light in weight and relatively inexpensive, they are used in handling and transporting unitized loads.

In this system palletized loads were transported from the freezer storage to the loading dock by a forklift truck. At the dock a forklift truck with a clamp attachment removed the cases from the freezer pallet and transferred them to a slipsheet, which was positioned on the plate of another forklift truck with a pull-pack attachment. The forklift truck with the slipsheet attachment moved the unitized load into the trailer and pushed it onto the floor of the trailer (fig. 10). A helper assisted the operators in the trailer. The crew included two forklift truck operators, one helper, and a checker. The cost of 18 slipsheets at 40 cents each for a full trailer load was $7.20.

The total labor and equipment cost to transport 1,600 cases of frozen food from the freezer and load in the trailer was $12.85, as shown in table 6.

Transportation.--Based on $2.28 per hundredweight and a load of 384 hundredweight, this cost amounted to $875.52 per trailer.

Unloading.--The wholesale warehouses studied did not receive slipsheeted loads. The slipsheeted unloading data in this report were simulated from slipsheeted unloading of other commodities that had a total unit weight almost identical to that of frozen citrus. Handling methods for both products were similar.

In unloading, a forklift truck equipped to handle slipsheets was used. This modified truck moved the slipsheeted load out of the trailer onto the dock and placed it on a pallet, which was positioned by an employee. The loaded pallet was picked up by a conventional forklift truck and moved into storage.

PN-4361

Figure 10.--Slipsheeted load of frozen food being pushed onto floor of trailer at processing plant.

Table 6.--Slipsheeted system: Labor and equipment time and costs to transport 1,600 palletized cases from freezer, transfer to slipsheets, and load in trailer at processing plant

Element	Labor		Equipment		Total cost
	Time	Cost 1/	Time	Cost 2/	
	Man-hours	Dollars	Hours	Dollars	Dollars
Transport cases from freezer to dock by forklift truck (round trip 300 ft).	0.76	2.05	0.76	0.75	2.80
Transfer cases from pallet to slipsheet by forklift truck with clamp attachment.	.22	.59	.11	.12	.71
Load slipsheets in trailer by forklift truck with slipsheet attachment.	2.63	7.10	1.69	2.24	9.34
Total	3.61	9.74	2.56	3.11	12.85

1/ At $2.70 per hour.
2/ At $0.99, $1.30, and $1.33 per hour for 1st, 2d, and 3d cost data, respectively.

The labor and equipment cost to unload a slipsheeted trailer load was $9.89, as shown in table 7.

The cost of the slipsheeted system to load ($12.85) plus the slipsheets ($7.20), transport ($875.52), and unload ($9.89) totaled $905.46.

COST COMPARISON OF FIVE SYSTEMS

A comparison of the total costs for the five handling systems is presented in table 8. These costs per trailer load ranged from $893.35 for the clamp-loaded and clamp-unloaded system to $989.54 for the palletized system. An analysis of labor, equipment, and material costs of the five systems shows that the clamp-loaded and clamp-unloaded system had the lowest cost ($17.83), followed by the palletized ($21.97), clamp-loaded ($29.41), slipsheeted ($29.94), and handstacked ($36.09) systems (see fig. 11). Thus, these costs ranged from $17.83 to $36.09 per trailer load, with the handstacked system costing more than twice as much as the lowest cost innovative system (clamp-loaded and clamp-unloaded).

The palletized system had the lowest total labor cost ($12.50), but it had two disadvantages in that an extra 1,440 pounds of pallets had to be shipped with the product and the pallets had to be returned. These added charges amounted to $32.83 (the extra 1,440 pounds) and $59.22 (return of pallets to processor) for total charges of $92.05. If this amount is subtracted from the total system cost, the palletized system would cost $897.49 and be very competitive with the other four systems. The slipsheeted system also had the added cost of the slipsheets ($7.20).

An advantage of the clamp-loaded and clamp-unloaded system was that there was no additional cost or charge for a shipping platform. With this system the handling cost ($7.83 for loading plus $10 for unloading) added to the transportation charges ($875.52) was $893.35. A clamp-loaded and clamp-unloaded system for handling frozen food at the processing plant and wholesale warehouse instead of the next least cost system (clamp-loaded) would result in a savings of approximately $11 per trailer load.

When the top cases of the unitized loads are tied, the lsbor and material required are an added expense for the palletized, slipsheeted, and clamp-loaded and clamp-unloaded systems. Also with this last system, spacers may be needed between the unitized loads in the trailer to facilitate getting the clamp attachment around these units during unloading.

The following conclusions can be drawn from the research:

- The unitized systems (palletized, clamp-loaded, and slipsheeted) can reduce labor costs for loading and unloading.

- A clamp-loaded and clamp-unloaded system would offer the lowest cost.

- Higher material and trsnsport costs per trip offset the savings in labor costs realized by the unitized systems.

Table 7.--Slipsheeted system: Labor and equipment time and costs to unload 1,600 cases from trailer and move to storage

Element	Labor		Equipment		Total cost
	Time	Cost 1/	Time	Cost 2/	
	Man-hours	Dollars	Hours	Dollars	Dollars
Transport 18 slipsheeted loads from trailer to dock and place on pallets by forklift truck with slipsheet attachment (18 round trips of 125 ft each).	0.94	5.41	0.90	1.20	6.61
Transport 2 loaded pallets at a time to storage by forklift truck (18 round trips of 280 ft each).	.49	2.82	.49	.46	3.28
Total	1.43	8.23	1.33	1.66	9.89

1/ At $5.75 per hour.

2/ At $1.33 and $1.08 per hour for 1st and 2d cost data, respectively.

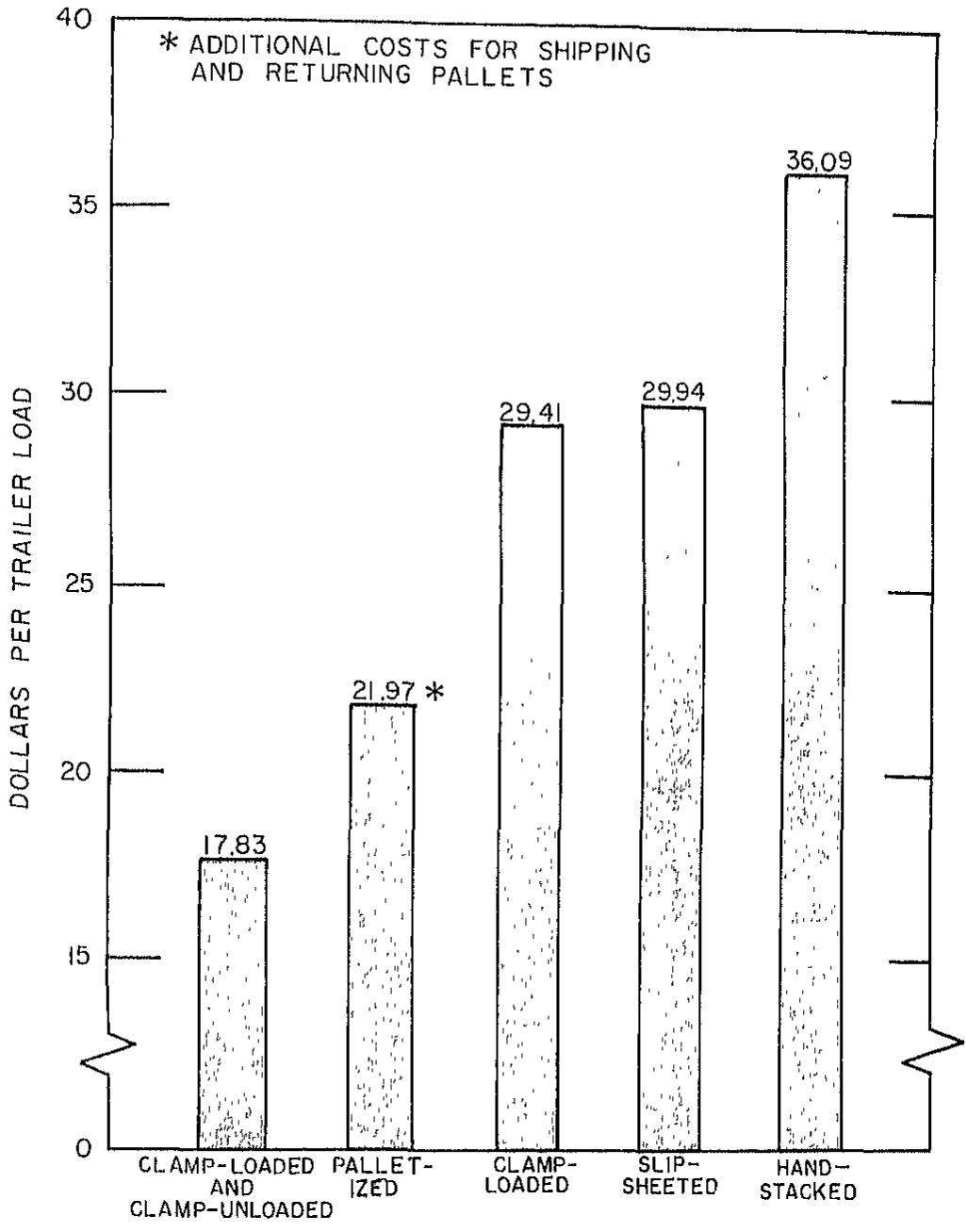

Figure 11.--Labor, equipment, and material costs of five systems for handling frozen food.

- Better communications between origin and destination are needed to devise loading systems that would be beneficial to both processor and receiver.

- A program of pallet exchange is needed between processor and receiver so that the problems of returning empty pallets could be resolved. In this study the processing plants that shipped on pallets sold them to the wholesale warehouse with the frozen food product.

- A standard-sized pallet for frozen food should be employed. Not all processors and wholesalers use the same size pallet; for example, pallets 48 by 40, 48 by 36, and 40 by 32 inches were used by firms participating in this study.

- Ways to reduce transportation charges should be studied.

Table 8.--Total costs per trailer load of 5 handling systems

System	Loading			Unloading		Total handling cost	Trans-portation	Total cost
	Labor	Equipment	Material	Labor	Equipment			
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Handstacked.....	12.95	1.56	...	20.88	0.70	36.09	875.52	911.61
Palletized.....	4.34	1.13	7.56	8.16	.78	21.97	1/967.57	989.54
Clamp-loaded.....	6.07	1.76	...	20.88	.70	29.41	875.52	904.93
Clamp-loaded and clamp-unloaded.	6.07	1.76	...	9.00	1.00	17.83	875.52	893.35
Slipsheeted.....	9.74	3.11	7.20	8.23	1.66	29.94	875.52	905.46

1/ Includes $59.22 for return of pallets to processor.

able 9.--Estimated annual ownership and operation costs for selected types of materials-handling equipment

Type of equipment	Initial cost per unit	Years of depreciation 1/	Annual ownership cost			
			Depreciation	Interest 2/	Insurance and taxes at 4 percent	Total
	Dollars	Number	Dollars	Dollars	Dollars	Dollars
Loading						
Forklift truck (sit-down type), 4,000-lb capacity.	9,100	10	910.00	410.00	364.00	1,684
Forklift truck with push-pull attachment.	12,780	10	1,278.00	575.00	511.00	2,364
Forklift truck with clamp attachment.....	12,500	10	1,250.00	562.00	500.00	2,312
Pallets (48 by 40 inch, hardwood, 2-way).	7	5	1.40	.30	.30	2
Unloading						
Forklift truck (stand-up rider).....	9,400	10	1,081.00	423.00	376.00	1,880
Pallet jack.....	3,650	10	395.00	164.00	146.00	705
Forklift truck with push-pull attachment.	12,780	10	1,278.00	575.00	511.00	2,364

Type of equipment	Annual operation cost			Total ownership and operation cost per--	
	Electricity 3/	Maintenance 4/	Total	Year	Hour 5/
	Dollars	Dollars	Dollars	Dollars	Dollars
Loading					
Forklift truck (sit-down type), 4,000-lb capacity.	148	141.00	289.00	1,973.00	0.990
Forklift truck with push-pull attachment.	148	141.00	289.00	2,653.00	1.330
Forklift truck with clamp attachment.....	148	141.00	289.00	2,601.00	1.300
Pallets (48 by 40 inch, hardwood, 2-way).	...	3.00	3.00	5.00	.002
Unloading					
Forklift truck (stand-up rider).....	148	141.00	289.00	2,169.00	1.080
Pallet jack.....	56	54.75	110.75	815.75	.410
Forklift truck with push-pull attachment.	148	141.00	289.00	2,653.00	1.330

1/ In accordance with U.S. Internal Revenue Service Bulletin "F" based on reasonable life expectancy.
2/ Computed interest is 9 percent per year for ½ the equipment life prorated over the full life.
3/ Power costs for battery charging of electric powered vehicles computed from manufacturers' specifications. Example: Battery is 18.5 kWh. Discharge rate per hour is 10 percent of battery capacity. 18.5 kWh X 0.10 equals 1.85 kWh capacity per hour battery charging requirements. 1.85 X 2 (50-percent charging efficiency) equals 3.70 kWh charging requirements for each hour of vehicle use. 3.70 X 0.02 (electricity cost per kilowatt hour) equals charging cost for each hour of vehicle use. 0.074 X 2,000 hours equals $148 per year power costs.
4/ Based on manufacturers' estimates.
5/ Based on 2,000 hours per year.